INTEGRATED HEAT EXCHANGER FOR VEHICLE AND METHOD FOR MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an integrated heat exchanger for a vehicle, and more particularly, to an integrated heat exchanger for a vehicle configured such that at least two tubes for radiating heat from fluid in the heat exchanger can be integrally formed and inner fins in the tubes can also be integrally formed.

2. Description of the Prior Art

In general, since engines that generate a driving force for running vehicles are operating in a high temperature state, sufficient heat radiation should be made from the engines. To this end, a cooling unit is provided in an engine room. Such a cooling unit is configured such that cooling water circulates between a water jacket formed on an engine block and a radiator installed to the front of the engine room.

Further, an air conditioning unit for regulating air within a car at a comfortable temperature is installed in vehicles selling currently at a market. Such an air conditioning unit causes a high-temperature, high-pressure gas refrigerant obtained by compression of a compressor to be converted into a liquid refrigerant by means of heat radiation in a condenser, and causes a pressure of the liquid refrigerant to be reduced, and causes air, of which temperature is reduced through the evaporator, to be supplied into the interior of the vehicle. Predetermined heat radiation should also be performed in such an evaporator.

Moreover, an oil cooler for cooling engine oil and transmission oil is mounted in the vehicle, and an intercooler may be installed according to kinds of engines.

The aforementioned respective units and devices should be subjected to sufficient heat radiation. Thus, the units and devices are configured to be installed in front of the engine room so that they can be smoothly and efficiently cooled.

In the past, all the heat exchange units mentioned above are individually

manufactured and installed. Thus, there is a problem in that manufacture and assembly processes are very complicated. In order to solve the problem, a variety of heat exchange units with radiator and condenser portions integrally formed therein have been proposed. Korean Utility Model Laid-Open Publication No. 2000-0008552 discloses such an integrated heat exchanger of which essential parts are illustrated in FIGS. 1 and 2.

As shown in the figures, the prior art heat exchanger comprises a pair of radiator tanks 26, 28 that are connected to a water jacket side of an engine; a plurality of radiator tubes 40 that are connected to the left and right radiator tanks 26, 28 and made of tubular bodies through cooling water can flow while radiating heat to external air; left and right condenser head pipes 36, 38 that are positioned in parallel with the radiator tanks 26, 28, respectively; a plurality of condenser tubes 42 that are positioned in parallel with the radiator tubes 40, made of tubular bodies through which high-temperature refrigerant can flow while radiating heat of the refrigerant to the external air, and connected to the condenser head pipes 36, 38, respectively; a plurality of fins 44 that are configured in the form of folds for increase of heat transfer with external air and arranged between a series of the radiator tubes 40 and the condenser tubes 42; and supporting stands 50, 52 for supporting a radiator 20 including the radiator tanks 26, 28 and a condenser 30 including the left and right condenser head pipes 36, 38.

However, the prior art is also only a technique in which the condenser 30 and the radiator 20 are integrally assembled to each other. Moreover, the respective tubes 40, 42 are separately manufactured and then assembled. Thus, it can be said that simplification of parts and improvements in assemblability are not be substantially and sufficiently achieved.

FIG. 3 shows a sectional view of a general condenser tube. As shown in this figure, since a plurality of inner fins 42b are installed in an outer casing 42a with a rectangular section, the condenser tube is divided into a plurality of tube paths by means of the inner fins 42b. Such a condenser tube should be designed to be able to withstand high pressure of the refrigerant transmitted from the compressor.

The condenser tube with the inner fins 42b as stated above is formed through extrusion molding process using relatively expensive equipment. Alternatively, it can be

configured in such a manner that the outer casing 42a is first formed using a metal plate with a constant width and the separately manufactured inner fins 42b are then inserted into the outer casing 42a so that they can be welded and integrally formed by means of brazing.

According to the aforementioned prior art, there is an inconvenience in that the respective tubes should be separately manufactured and an assembly problem resulting from the inconvenience. In case of a tube, e.g. a condenser tube, configured to be able to withstand high pressure of fluid flowing the tube by installing the inner fins in the tube, there is another process problem in that the separately manufactured inner fins should be first inserted into the tube and then the brazing should also be performed.

SUMMARY OF THE INVENTION

The present invention is conceived to solve the aforementioned problems in the prior art. An object of the present invention is to provide a heat exchanger wherein a pair of tubes can be integrally formed and inner fins to be installed in any one of the tubes can also be integrally formed simultaneously.

According to an aspect of the present invention for achieving the object, there is provided a heat exchanger for a vehicle, which comprises (a) tube assemblies each of which is formed from a single sheet of metal plate and comprises a first tube formed by bending a lateral end portion of the metal plate onto a top surface of a body portion of the plate, a second tube formed by bending the other lateral end portion of the metal plate onto the top surface of the body portion, and inner fins formed in at least any one of the tubes for partitioning the interior of any one of the tubes into several compartments by bending an inner fin forming portion, integrally formed at an outermost side of the metal plate, onto the top surface of the metal plate, and (b) radiating fins installed between the tube assemblies.

It is preferred that longitudinal slits be formed at the body portion between the first and second tubes.

Further, the radiating fins may be separately formed in pairs, and the pairs of radiating fins may also be interposed between the adjacent first tubes and between the adjacent second tubes, respectively.

Alternatively, each of the radiating fins may be formed as a single piece in order to be interposed between the adjacent tube assemblies, and longitudinal slits may be formed at a middle portion of each of the radiating fins.

Furthermore, it is preferred that an outermost part of the lateral end portion of the tube with no inner fins formed therein be in surface contact with the top surface of the body portion.

According to another aspect of the present invention, there is provided a method for manufacturing a heat exchanger for a vehicle including tube assemblies each of which has a pair of tubes integrally formed from a single sheet of metal plate, and fins interposed between the tube assemblies for performing heat radiation. The method comprises the steps of forming an inner fin forming portion for providing inner fins in the tubes on at least one lateral end portion of the single sheet of metal plate; forming the pair of tubes by bending both lateral end portions at least one of which includes the inner fin forming portion to bring the end portions into contact with a top surface of a body portion of the metal plate; and performing a brazing process in a state where the fins are interposed between the tube assemblies.

According to a further aspect of the present invention, there is provided a method for manufacturing a heat exchanger, which comprises the steps of forming an inner fin forming portion for providing inner fins in a first tube on a lateral end portion of a metal plate; bending the inner fin forming portion to come into contact with a top surface of a body portion of the metal plate; forming the first tube by bending a part of the body portion including the inner fin forming portion again to bring the inner fin forming portion into contact with the top surface of the body portion; and forming a second tube by bending the other lateral end portion of the metal plate to bring an outermost part of the other lateral end portion into contact with the top surface of the body portion.

Further, the steps of forming the first and second tubes may be simultaneously performed.

Furthermore, it is preferred that tube assemblies each of which comprises the first and second tubes be arranged one above another. The method may further comprise the step of brazing the tube assemblies and radiating fins in a state where the radiating fins are

interposed between the vertically arranged tube assemblies.

More preferably, the outermost part of the other lateral end portion of the second tube is bent to come into surface contact with the body portion.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become apparent from the following description of a preferred embodiment given in connection with the accompanying drawings, in which:

FIG. 1 is perspective view of a conventional heat exchanger;

FIG. 2 is a partially enlarged perspective view of the conventional heat exchanger;

FIG. 3 is a sectional view of a condenser tube;

FIG. 4 is an exemplary perspective view of a heat exchanger tube according to the present invention;

FIG. 5 shows an example of a process of manufacturing the tube assembly according to the present invention; and

FIG. 6 is a perspective view of a heat exchanger according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, a preferred embodiment of the present invention will be explained in detail with reference to the accompanying drawings.

FIG. 4 shows an exemplary perspective view of an integrated heat exchanger tube assembly 100 according to the present invention, and FIG. 5 shows an example of a process of manufacturing the integrated tube assembly according to the present invention.

Referring first to FIG. 4, a tube assembly 100 for use in an integrated heat exchanger of the present invention comprises a first tube 120 formed on one side (left side in the figure) and a second tube 140 formed on another side (right side in the figure).

The first and second tubes 120, 140 are integrally formed with each other and formed out of a single sheet of metal plate (e.g., an aluminum plate having superior heat conductivity). Thus, the tube assembly of the present invention is integrally formed out of a single sheet of metal plate in such a manner that first and second tubes 120, 140 are

arranged at opposite sides, respectively.

The first and second tubes 120, 140 are formed by bending both lateral end portions of the single sheet of metal plate upwardly and inwardly with respect to a body portion 130.

Further, inner fins 122 are formed in the first tube 120 such that the tube 120 can withstand pressure of fluid flowing through the tube. The inner fins 122 are integrally formed with the first tube 120. That is, the inner fins 122 can be integrally formed in the first tube 120 by manufacturing an end portion of the first tube 120 in the form of waves and then bending the manufactured end portion onto a top surface of the body portion 130. A flow path through which the fluid can flow is formed in the first tube 120 with the inner fins 122 formed therein. For example, the first tube 120 is a condenser tube through which refrigerant can flow while achieving heat exchange with external air. A process of forming the inner fins 122 and the second tube 120 will be described later.

An outermost end portion 142 of the second tube 140 is formed such that it is upwardly bent and then comes into contact with the upper surface of the body portion 130 of the tube assembly 100 of the present invention.

Since the outermost end portion 142 of the second tube 140 are processed to come into surface contact with the body portion 130, it can be securely welded to the body portion during the brazing process of the tube assembly 100. Thus, a flow path through which fluid (e.g., anti-freezing solution in the radiator) can flow is formed in the second tube 140 in a state where the outermost end portion 142 is in contact with the top surface of the body portion 130.

Further, slits 132 that are partially cut away along a longitudinal direction of the tubes are formed on the body portion 130 between the first and second tubes 120, 140 so as to prevent heat conduction between the both tubes.

A process of manufacturing a tube assembly 100 according to the present invention will be now described with reference to FIG. 5.

The tube assembly 100 of the present invention is manufactured from a single sheet of aluminum plate P with a predetermined width. FIG. 5 (a) shows a state where an inner fin forming portion 122a for forming inner fins 122 has been formed on one portion

(a left side of the figure) of the flat aluminum plate. The inner fin forming portion 122a is a part that will become the inner fins 122 shown in FIG. 4 through a predetermined process to be described later.

As described later, it the inner fin forming portion 122a is configured such that the first tube 120 is divided into a plurality of compartments to allow the first tube 120 to withstand the pressure of the fluid flowing through the tube, the shape of the inner fin forming portion is not necessarily limited. As illustrated in the preferred embodiment of the present invention, the inner fin forming portion 122a may be formed to have a wavy section.

For example, the inner fin forming portion 122a is formed by causing a plurality of rollers to press onto top and bottom surfaces of the flat aluminum plate. These rollers are substantially configured to have a plurality of stages so that the inner fin forming portion is preferably formed by means of several stages of the pressing process. For example, the rollers with ten stages or more may be used.

After the inner fin forming portion 122a has been completed as shown in FIG. 5 (a) through the above process, the inner fin forming portion 122a will be bent clockwise by 180 degrees as shown in FIG. 5 (b) to come into contact with a top surface of a body portion 130 that is a base surface. It is apparent that the inner fin forming portion 122a can be bent by the 180 degrees according to a variety of methods.

That is, the inner fin forming portion 122a can be bent by the 180 degrees to come into contact with the body portion 130 by a single bending process, for example. However, the inner fin forming portion 122a can also be bent by the 180 degrees to come into contact with the top surface of the body portion 130 using the plurality of rollers through multiple stages (e.g., ten stages or more) of the bending process.

And simultaneously a process of forming a second tube 140 at the right lateral end portion of the body portion 130 will be started. For example, the right end portion of the body portion 130 is first bent upwardly so that the right outermost end portion 142 will be formed upwardly.

Next, in the process shown in FIG. 5 (c), a part 124 of the body portion 130 on which the inner fin forming portion 122a contacts is again bent clockwise by 180 degrees.

The first tube 120 can be substantially formed at the left side of the body portion 130 by bending the part 124 of the body portion clockwise by 180 degrees. Herein, the part 124 of the body portion can be bent by 180 degrees according to the variety of methods. As described above, for example, the part 124 of the body portion can be formed by bending it through the multiple stages of the bending process using the plurality of rollers.

Simultaneously, the second tube 140 is also formed at the right side of the body portion 130. That is, the second tube 140 is formed at the right side of the body portion 130 by causing the right lateral end portion 142 to come into contact with the top surface of the body portion 130 positioned around a middle portion thereof when the right part of the body portion 130 including the right end portion 142 are bent.

The inner fin forming portion 122a and the right end portion 142 are integrally welded to the top surface of the body portion 130 by performing a process of brazing the inner fins 122 within a predetermined furnace in a state where the inner fin forming portion 122a and the right end portion 142 are in contact with the top surface of the body portion 130 as shown in FIG. 5 (c). Thus, the complete first and second tubes 120, 140 can be achieved.

Here, the outermost end portion 142 of the second tube 140 is preferably formed to come into surface contact with the top surface of the body portion 130. Accordingly, since the outermost end portion 142 is more firmly welded to and comes into close contact with the body portion 130, the second tube 140 can be more easily formed.

It can be understood from the illustrated preferred embodiment of the present invention that the inner fins 122 have been formed in the interior of the first tube 120, whereas the second tube 140 has been formed to be merely cylindrical. However, it is also possible to form the inner fins in the interior of the second tube 140 through the same configuration and process as described above. Conversely, it is possible that the first tube 120 is formed to be merely tubular, whereas the integrated inner tubes are formed in the interior of the second tube 140.

Therefore, in the tube assembly 100 according to the illustrated preferred embodiment, the first tube 120 and the second tube 140 can be used as the condenser tube and the radiator tube, respectively. If the inner fins are formed on both tubes 120, 140 of

the tube assembly 100, the tube assembly 100 can be used as a tube for use in a set of the condenser and oil cooler. It is apparent that such selective combinations allow the tube assembly 100 including the first and second tubes 120, 140 to be applied to the tube for use in a set of the radiator and oil cooler, a set of the radiator and intercooler, a set of the condenser and intercooler, a set of the oil cooler and intercooler, etc.

A whole configuration of the heat exchanger using the tube assembly 100 will be now explained with reference to FIG. 6.

An example in which the first tube 120 is used as the condenser tube and the second tube 140 is used as the radiator tube in the tube assembly 100 according to the present invention is shown in FIG. 6. Condenser head pipes 120A, 120B are installed to both ends of the first tube 120, and a refrigerant flows through the first tube 120 connected between the condenser head pipes 120A, 120B. Further, radiator tanks 140A, 140B are installed to both ends of the second tube 140, and the anti-freezing solution flows through the second tube 140.

A plurality of tube assemblies each of which includes the first and second tubes 120, 140 formed out of a single piece as described above are installed one above another by a predetermined interval, and radiating fins 200 are further installed between the sets of the first and second tubes 120,140. In addition, the tube assemblies and the radiating fins 200 are integrally welded to each other at given contact surfaces by means of the brazing process performed within the high-temperature furnace.

It is apparent that the radiating fins 200 are used to efficiently radiate the heat transferred from the respective tubes 120, 140 by the heat conduction. The radiating fins 200 are formed in such a manner that a specific shape is repeated at a constant interval, i.e., peaks and valleys thereof are continuously arranged. Thus, a surface area of the radiating fins brought into contact with the air can be maximized.

Further, according to the illustrated preferred embodiment of the present invention, only one of the radiating fins 200 is interposed between the tube assemblies each of which includes the first and second tubes 120, 140. In a case where the radiating fin 200 is integrally formed as a single piece, it is preferred that longitudinal slits 210 be formed at the middle portion in the width direction of the radiating fin 200 in order to minimize the

heat transfer between the first and second tubes 120, 140.

Although it has not been illustrated herein, the radiating fins 200 may be configured in such a manner that a pair of fins is individually interposed parallelly between the tube assemblies. By doing so, the heat conduction between the pair of fins is not produced, and thus, the heat can be radiated more efficiently from the tubes.

According to the present invention, a pair of tubes for different uses can be formed as a single piece. Thus, there are advantages in that a whole configuration of a heat exchanger can be simplified and more simple and easy manufacture and assembly thereof can be obtained. Furthermore, since inner fins are integrally formed with the tubes themselves, such as the condenser tubes and oil cooler tubes, in which the inner tubes should be installed, there is another advantage in that the tubes can be more simply and easily manufactured, and thus, the assembly of the heat exchange units can also be more easily achieved.

It can be understood that the tube assembly 100 including the first and second tubes according to the present invention can be applied to the cooling tube for use in a vehicle. Further, it is apparent to those skilled in the art that various changes or modifications may be made to the present invention without departing from the technical spirit and scope of the invention. Therefore, the present invention should be construed based on the appended claims.